DETERMINANTS TO MOBILITY
- Examples from Denmark, Norway and Sweden -

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1 Introduction

The article is based on my paper ***Determinants to mobility - Introduction to transport economics with examples from Denmark, Norway and Sweden***, WP1/1997 - ILT.

The document reflects my interest in understanding long-term development trends in transport, their causes and their effects on society. Even though being an economist by education, history, and in particular transport history, has always fascinated me. The time series presented go as far back in time as to 1929.

Fundamental to the desire for understanding how transport unfolds itself as integrated part of our social life, is my conviction that substantial parts of transport policy rest on an illusion that transport development can be decisively influenced by policy instruments which are within socially accepted limits. On the other hand in a modern western society the social trends influencing transport development the most, are not very much within the domain of transport policy.

2 Characteristics of transport

Transport can be analysed with concepts and relationships from several scientific disciplines. Taken separately, none of them can throw enough light on causes and effects in transport, because transport is intrinsically interwoven with most everyday social activities. To borrow a term from economics, transport is ***'complementary'*** to these activities, and can simultaneously create advantages and disadvantages to many people. However, such advantages and disadvantages are not evenly distributed between population groups and throughout society.

Even though a multi-disciplinary scientific approach to transport is needed, none such exists at present. We have to content ourselves with partial contributions from various scientific disciplines such as branches of economics, sociology and geography. Each has to be used quite extensively to provide even a limited insight into transport problems. Let us consider briefly why transport poses both a blessing, a problem and a challenge to society, policy and science.

In the western world, transport has increased so much over the last few decades that the social cost of transport has become apparent. Too much transport is a threat to both human welfare, environmental quality and industrial efficiency. So there might be a good cause for political intervention.

For decades, transport had been one of the most sheltered sectors in Western European economies. From the middle of the eighties the transport policy in the European Union (EU) became more and more liberalistic. This meant that the transport sector was given more and more responsibility for making its own decisions on how, when and where to operate and had to rely on its own financial resources for survival. Important keywords characterising this political process are deregulation, privatisation, harmonisation and standardisation. With the establishment of the Single Market from 1 January 1993 there is in principle freedom of movement for people, goods, capital and services in the EU. Numerous transitional arrangements exist, however, some of which will still be effective beyond the turn of the century. This complexity of arrangements means that transport cannot be analysed within a single framework such as the

competitive market or the monopoly system. Several forms of strategic alliances exist in parallel, and the analysis of such alliances is necessarily complicated.

Transport is a service which cannot be stored, but must be consumed when produced, thereby creating advantages and disadvantages, at a specific time and in specific locations or be lost. So both advantages and disadvantages have a geographical and a time dimension. Moreover the services provided show systematic variations in time and place. Some times certain transport infrastructure is congested, at other times it is underutilised. Income and outlay by transport mode owners on infrastructure do not accrue on a parallel time basis and can create serious profitability problems. The owners of transport infrastructure also have greater or lesser control of the vehicles using that infrastructure, and this too gives rise to specific problems.

Transport is an important activity sector in society, whether we measure it in terms of economic performance, employment, welfare or investment. Because of this, it is very difficult for anybody to intervene, on either a local or national scale, without creating serious unexpected and undesired results.

The social costs of transport from accidents, noise, pollution of many sorts, vibration, anguish and stress etc are obvious, and have been increasing. But transport demand is derived from other social requirements. Greater public control of transport would have negative repercussions on an activity which is otherwise highly desirable from the society's standpoint.

The term mobility is related to both quantitative and qualitative aspects of traffic and transport. It has no universally accepted definition. So let us approach some tentative definitions stepwise.

We might say that a certain part of transport infrastructure is navigable (e.g. a canal or a river) or passable (e.g. a road). A location we might characterise as accessible if there is passable infrastructure for a traveller to get from the start of the journey (origin) to the desired point of destination where the location is and if there is some mode of transport available to take the traveller from the point of origin to the point of destination. The examples given, point to some necessary conditions which have to be fulfilled before mobility can be achieved: A relevant transport infrastructure must be passable with an available transport mode to make a desired location accessible to our potential traveller or a shipper in the case of goods transport.

It is important to decide in which context the term available shall be perceived. If a family car is occupied by someone in the family, then the car might not be available to the rest of the family. If a mode of transport is too expensive for a potential traveller to use, then an otherwise desired journey might be impossible to undertake. Similarly if we need to be at some place within say an hour or before 8 o'clock in the morning, and this is not possible due to congestion, then this place will be inaccessible.

The examples given, illustrate the point that it might for some purpose be useful to make a distinction between actual and potential accessibility, mobility etc. In this article we, however, concentrate on actual performance and achievement. Some important social issues are then left out such as a discussion of the potential for incorporating handicapped people in the more normal travel patterns of the rest of the population. Specially equipped vehicles supplied by a local community can offer some groups of handicapped people a travel behaviour more or less equivalent to that of the mobile part of the population. The local community then has in its power to transform potential mobility into actual mobility.

Even when we concentrate on actual mobility, several definitions offer themselves. Mobility can be measured in terms of time spent in transport, in speeds achieved, in kilometres travelled or transported, in volumes transported, in money spent on transport etc. We might even construct quality indicators or some more or less complicated indicator relevant for mobility. The perspective might be a single traveller, a firm,

a group or society at large etc. In the article I mostly use passenger-km and tonne-km as mobility indicators. I refer to WP1/1997 - ILT for other mobility measures.

If we in this document had been concerned with the issue of how to attain mobility which in some sense ought to be sustainable, we would have to distinguish more options than we have done above. The CO_2 exhausts from cars which contribute significantly to the global warming increase in proportion to energy consumption. This consumption is only indirectly linked to passenger-km or tonne-km, but more directly linked to vehicle-km. If we measure mobility by e.g. passenger-km we might envisage a reduction in vehicle-km by 50 per cent if we could pack the car with twice as many as today. If this could be achieved by some policy measures, we could both preserve as high mobility as today, by a reasonable definition of mobility, and at the same time reduce the exhausts to 50 per cent of current levels. So it is extremely important to specify concepts used in any important application.

3 Factors influencing transport development

Levels of economic activity and material welfare are two very important factors in any study of transport demand. In an open economy such as we have in the Scandinavian countries, economic and political conditions in trading partner countries also influence the volume of exports and imports and therefore transport demand. Tourism is an important aspect of the life of Scandinavians and significant to their employment. Investment in transport infrastructure as well as in aircraft, rolling stock, ships and vehicles, influence competition in transport, efficiency in industry, welfare of a country, and location of dwellings and production. All of these will in turn have a significant influence on transport demand.

For the sake of clarity and to provide an overview, it is useful to list the factors influencing transport demand. This listing can be done in various ways, both regarding conceptual details and precision, but the one used here has at least some pedagogic advantages.

Trends and structural changes:
- ✓ The level and redistribution of economic activity, e.g. income and production
- ✓ Restructuring of production activities, e.g. growth in service industry, new industrial management principles and logistics practice, new organisational structures.
- ✓ Change in land use patterns.
- ✓ Socio-demographic changes.
- ✓ Research and development.

User choice:
- ✓ Value/weight ratio of commodities
- ✓ Travel times
- ✓ Travel fares and travel costs
- ✓ Transport quality parameters, e.g. availability frequency, regularity, reliability, safety, security.

Policy instruments:
- ✓ Market organisation measures
- ✓ Cost charging measures
- ✓ Standardisation and harmonization measures
- ✓ Research initiatives.

As implied by the extensive list of transport demand factors given above, the analysis of transport is necessarily complex. It requires special attention to time, place and the total set of conditions governing transport demand. The factor mix and the importance of each factor vary from country to country and from time to time. For these reasons, accuracy and precision cannot be expected in transport demand analysis. There are too many unknown factors at any one point in time and place. Even if the level of basic

understanding of the underlying structure might be high, the ability to explain satisfactorily tends to be limited. But as indicated later in the article, some few variables dominate and even correlate with several others so that a simplified approach to understanding mobility is presented in the article.

4 Reasoning behind the structuring of time intervals

Historians and other professions interested in long-term development of social phenomena divide the passing of time into distinct epochs, as social events do not unfold evenly over time. I follow this line of thinking and transform the passing of time into some intervals relevant for my purpose. For ease of data compilation and presentation it will be a substantial gain if these intervals can all be of equal length. This is what I have done. However, when we face the question of how to divide time in the most fruitful way, we must admit that the answers are not obvious.

Experience shows that transport is closely linked to the level of economic activity and material welfare of a free society, but this level does not develop evenly over time. There are short-term waves forming recession as well as recovery periods, together forming a business cycle. There may also be underlying long-term trends which materialise as long-term cycles appearing at intervals such as fifty years or more.

In the article I am concerned with modern transport history in Scandinavia. Basically I am interested in tracing the influence of the motor vehicle. By the end of 1994 there were 1.95 million automobiles in Denmark out of which 1.62 million were passenger cars. In Norway there were 2.02 million automobiles out of which there were 1.65 million passenger cars and in Sweden 3.91 million automobiles out of which 3.59 million were passenger cars. By the end of 1929 there were only 98 000 automobiles in Denmark, 42 000 automobiles in Norway and 137 000 automobiles in Sweden.

Sweden is the only Scandinavian country with motor vehicle production. Swedish motor vehicle production dates back to the latter part of the twenties, but by 1930 only about 2000 were produced. From 1929 a world wide economic recession began, leaving its impact also on Sweden.

It can be useful to study long-term development from points in time with distinct characteristics. For such reasons it might therefore be convenient to date the start of the epoch back to 1929. Admittedly the end of the First World War could make an even better starting point for the time series. However, there are statistical reasons in favour of 1929 as the beginning of the epoch. Indicators of economic activity such as gross domestic product (GDP) and private final consumption expenditure (C_p) lose much of their precision beyond 1929. So I have considered the development of indicators from that time on.

Currently the economies of the Scandinavian countries are booming after having recovered from economic recession in the beginning of the nineties. Economic growth had culminated by the end of the eighties, and for practical purposes we can pinpoint the culmination to 1989. That year can be considered the end of a business cycle comprising recession from 1979 for some years and recovery from then on to 1989. In 1979 oil prices had soared for the second time in a few years and shaken the world economy once more.
After having studied the development of business cycles after 1929 I have partitioned historic development into five-year intervals and compiled relevant data for every five-year from then on. To illustrate the consequences I present in figure 1 the long-term development in the volume of registered cars in the three Scandinavian countries between 1929 and 1994.

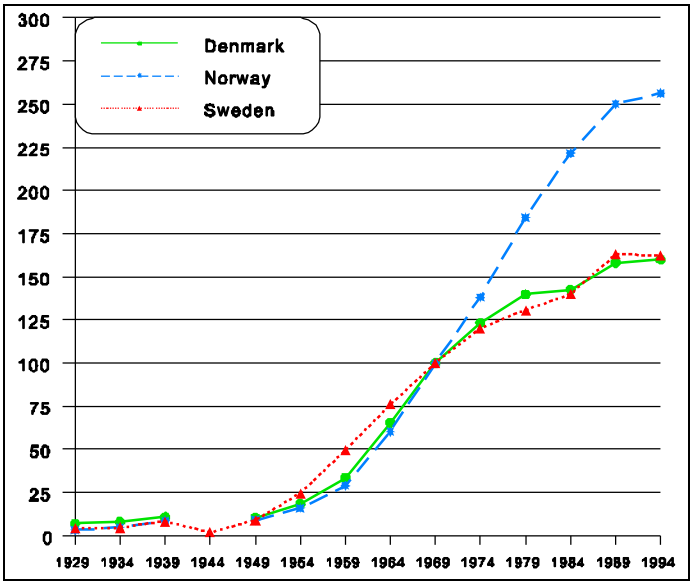
To understand more fully the development shown in figure 1 we must remember that the number of people living in the three Scandinavian countries is different although distributions have been rather stable all through the century. In 1929 there lived 26 per cent more people in Denmark than in Norway and 119 per cent more in Sweden than in Norway. By 1989 the difference had narrowed to 21 per cent more in Denmark

and 103 per cent more in Sweden. By 1929 we can conclude that based on historic information Denmark was relatively more motorised than Sweden and much more than Norway.

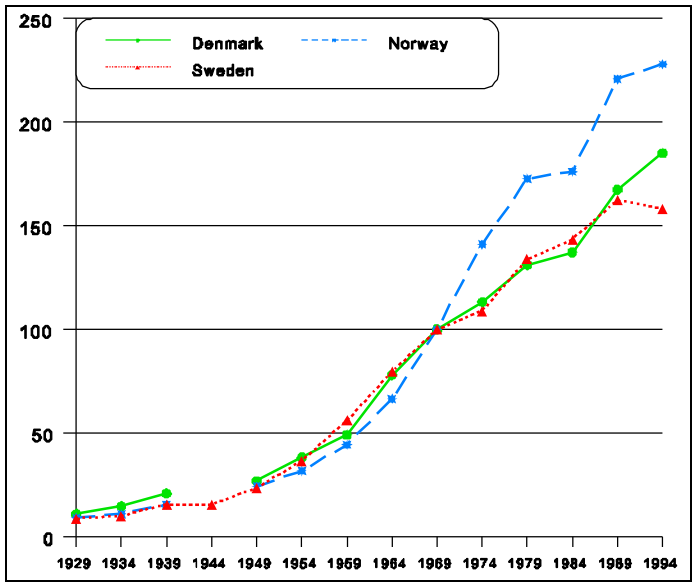
Due to its strong motor car industry the volume of registered cars in Sweden probably reflects well market forces and the purchasing power of the population. Denmark and in particular Norway were severely hit by the Second World War in contrast to Sweden. In Norway the purchase of private cars was even rationed until the end of 1960.

It might for at least two reasons appear strange that development in Denmark and Sweden has been rather similar according to figure 1. The Danish land area is very flat and only 13 per cent of the Swedish land area. For that reason the need for the motor car might appear less pressing. Besides the private car is much heavier taxed in Denmark than in Sweden. Compared with countries in the European Union (EU) Danish motor car taxes seem to be the highest, even higher than in Norway, which also tax higher than EU Member States. Probably selling prices for cars in Denmark have been at least 50-100 per cent higher than in Sweden. In the period studied in figure 1 income levels were comparable in Denmark and in Sweden.

The reason for the similarity may very well be simple. After the Second World War the Scandinavians reached income levels permitting average income earners to acquire cars, and the desire to get one must have been felt strongly. Since the car was more costly in Denmark than in Sweden, a simpler car model could serve its purpose, because having a car at hand was the most important thing, not the car make itself. The Norwegian development confirms this observation. When the rationing system was abolished in 1960, a tremendous growth started spurred by the continuing growth in income when the era of the gas and oil industry started in the seventies.



5 Aspects of mobility

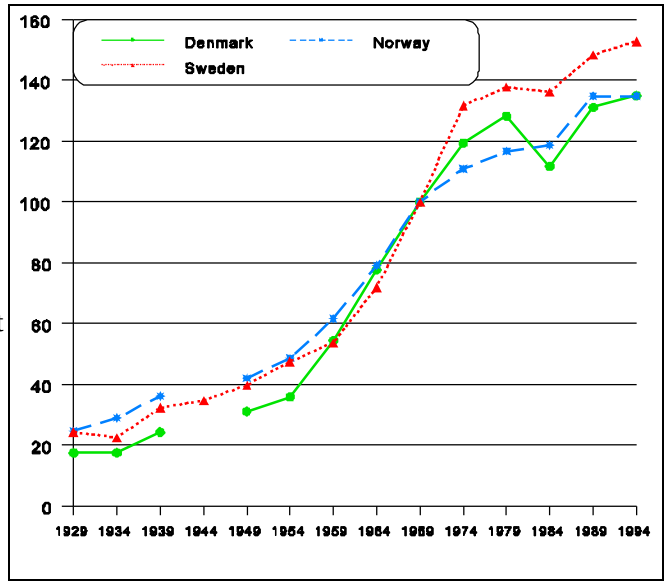


As discussed in chapter 2 the concept mobility has many facets and dimensions. Actual choice of quantification must depend on the purpose of the exercise and might very well result in a multiple choice situation. The indicators selected now highlight some characteristic development trends.

Figure 2 and 3 highlight the development in passenger-km and tonne-km between 1929 and 1994 in the three Scandinavian countries. Figure 2 indicates to my mind a strikingly similar pattern of development between the three countries. The more rapid growth in passenger-km in Norway than in Denmark and Sweden from the seventies can be explained in terms of suppressed demand when car purchase was rationed and rapid income growth in the seventies and eighties.

Domestic goods transport (tonne-km) in the three Scandinavian countries does not develop so much in parallel as seems to be the case for domestic passenger-km. Important reasons for this might be:

- ✓ different industrial structure relating to both composition and development over time
- ✓ differences in location of export industry in relation to ports and thus different needs for domestic transport
- ✓ geographical differences resulting in different needs for domestic transport.



Figures 2 and 3 do not show mobility levels but only relative development. Mobility levels are shown in the following information boxes, first passenger-km and
its most influential explanation factor, income approximated by private final consumption expenditure.

Mobility measured as domestic passenger-km per inhabitant per day			
Year	**Denmark**	**Norway**	**Sweden**
1929	3.4	2.2	2.8
1939	6.0	3.4	4.9
1949	7.0	4.9	6.7
1969	23	17	25
1989	36	34	37
1994	39	34	35

Private final consumption expenditure (C_p) per inhabitant. ECU (1985 prices)			
Year	**Denmark**	**Norway**	**Sweden**
1929	3154	2580	2855
1939	3614	3161	3499
1949	3777	3492	4132
1969	6590	5821	6972
1989	8415	9569	9059
1994	9340	10365	8385

The growth has been particularly strong after the Second World War. On average mobility has increased by 4.2-5.0 per cent per year between 1949 and 1989. The relative difference has diminished between the Scandinavian countries. This is striking since there are so many aspects of social life which differ between the three countries. In the forty-year period 1949-1989 private final consumption expenditure per inhabitant and at constant prices (material welfare) increased on average by 2.0 -2.6 per cent per year. As the information box shows material welfare levels are comparable between the three Scandinavian countries.

The ratio between the two figures can be interpreted as an elasticity. The following information boxes summarise the development in the three Scandinavian countries. Although mobility and consumption vary between the Scandinavian countries, the elasticity (ratio) is surprisingly equal between the countries.

Annual percentage change 1949-1989			
	Denmark	**Norway**	**Sweden**
Mobility	4.2	5.0	4.4
C_p ECU (1985 prices)	2.0	2.6	2.0

Ratio between mobility and C_p ECU (1985 prices) - mobility elasticity in relation to expenditure - 1949-1989		
Denmark	**Norway**	**Sweden**
2.1	1.9	2.2

Although total mobility levels tend to be equalised between the three Scandinavian countries, there are distinct differences as to the composition of mobility. Car density (cars per inhabitant) are now lower in Denmark than in Norway and Sweden with Sweden on top. This ranking can be explained in terms of income trends and car prices. An example of a car price: In September 1994 an Opel Astra (1,6 GL, 3-doors) would cost in Danish currency 161 500 DKK in Denmark, 163 500 DKK in Norway and only 104 500 DKK in Sweden. When it comes to usage of the car, Denmark is on top. In 1993 annual mileage travelled by a private car was 18 600 km in Denmark, 13 800 km in Norway and 16 500 km in Sweden. Actual petrol prices explain at least in part, this difference. In 1993 the price of unleaded petrol was per litre in Danish currency 5.18 DKK in Denmark, 7.30 DKK in Norway and 6.39 DKK in Sweden.

As we have seen the mobility elasticity has been high and approximately the same in the three Scandinavian countries over the forty-year period. A great number of social factors have been active in this period and several of them have been positively correlated with income. In the post-war period technological development in transport and communication has been formidable. Transport policy instruments must to a substantial degree have supported income effects even though the three Scandinavian countries have not carried out the same transport policy. Income policy is not part of transport policy indicating that it would have been next to impossible to substantially alter the development trend.

As outlays on transport (and communication) has a close bearing on mobility, long-term trends of such outlays also tell their story of how and why mobility has developed in the way it has. From very low levels the households in Scandinavia have spent relatively more and more of the household budget on transport and communication. By 1989 households in the three Scandinavian countries actually spent nearly the same relative amount (16%) of their private final consumptions expenditure (C_p) on transport and communication (C_{pt}) measured at current prices.

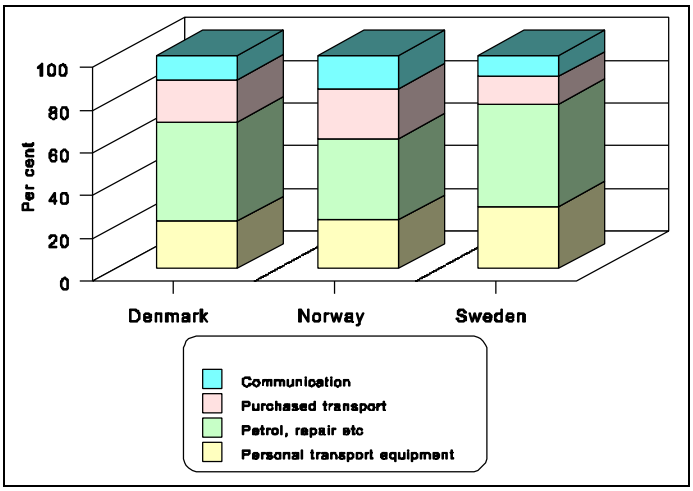


Figure 4 shows private final consumption expenditure on transport and communication distributed in per cent between certain sub-groups for 1989. The impression is clearly one of similarity between the three Scandinavian countries. The dominant item is outlays on operations of personal transport equipment in all three countries.

Turning to domestic tonne-km the volume of domestic tonne-km is calculated in relation to gross domestic product (GDP). The following information box shows the result of the calculations:

Domestic tonne-km per thousand kroner of gross domestic product, national currency (1985 prices)

Year	Denmark	Norway	Sweden
1929	14	52	58
1939	15	56	60
1949	17	50	53
1969	24	53	61
1989	21	32	59
1994	20	27	61

Some impressions stand out clearly. One is the relative stability in the figures in Denmark and Sweden. Another is the decline in Norway occurring when the gas and oil era started from the seventies. A third impression is the differences in the level of the figures between the three Scandinavian countries, probably reflecting structural differences in industry.

To throw some more light on details as to mobility I have in an appendix summarised indicators of transport performance between the years 1949 and 1989. The appendix has lead me to draw the following conclusions:

Domestic passenger-km have increased significantly in the forty year period 1949-1989 both in Denmark, Norway and Sweden, while passenger-km by public transport modes have only doubled in these years. Rail passenger transport has barely increased at all. From other statistics than in the appendix it can be demonstrated that it is above all air transport which has given growth impetus to passenger transport by public transport modes.

Passenger transport by road vehicles, in particular by cars, has been responsible for the transformation of society in post-war years in all three Scandinavian countries. In the early post-war years the dominant transport mode was the railways, but very soon passenger-km by cars surpassed passenger-km by the railways.

Passenger-km by cars have increased much faster than private final consumption expenditure at constant prices. As a consequence private final consumption expenditure on private cars has grown tremendously. The fabulous growth in the Norwegian figure reflects that households were not allowed to buy new cars before the end of 1960. In Sweden expenditure on personal transport equipment has, according to table 1, grown by a factor of 35. This is equivalent to an annual average increase over the forty years of 9.3 per cent. At the same time the volume of new car registrations has increased by a factor of 22, which is equivalent to an annual average increase by 8.1 per cent. The difference between 9.3 and 8.1, which is 1.2, may be interpreted as annual average percentage growth in the quality of new cars. Similarly the difference in Denmark between the two figures 9.8 and 7.9, that is 1.9, can be interpreted as growth in the quality of new cars.

In the same manner as we have reasoned above, we can compare passenger-km by cars, the stock of cars and expenditure on operation of personal transport equipment. In Norway and Sweden passenger-km by cars and the stock of cars have grown approximately in proportion, but outlays have increased much less. In Norway expenditure has increased on an annual average basis by 7.7 per cent and passenger-km by cars by 8.5 per cent. The difference, 0.8 per cent, may be interpreted as productivity and quality gains in the operation of cars. In the Swedish case expenditure has increased on an annual average basis by 6.2 per cent

and passenger-km by 7.5 per cent per year. The difference of 1.3 per cent may be interpreted as productivity and quality gains in the operation of cars. For Denmark it is not possible to draw a similar conclusion as passenger-km has increased slightly less than expenditure.

Turning to domestic tonne-km we find that overall tonne-km has increased slightly more than gross domestic product at constant prises for Denmark and Sweden, but somewhat less in Norway. When we look at the more detailed picture in table 1, we see that tonne-km by railways have been reduced in Denmark, increased very little in Norway and become a bit more than doubled in Sweden. The growth above all has occurred in road transport. From other statistical sources than the appendix it can be mentioned that timber floating has disappeared in Norway and Sweden. Coastal shipping has increased over the forty-year period.

Just as the car has made revolution in passenger transport, the lorry has done the same in goods transport. As a consequence of the very insignificant change in railway transport in post-war years, railway lines have been closed down by all three Scandinavian countries. The road structure has increased very moderately, but it is very difficult to find out by how much because past statistical information is incomplete.

Appendix

Table 1 *Denmark*: Summary indicators of transport performance 1949-1989. 1949=100		
	1949	**1989**
Domestic transport Passenger-km	100	625
Passenger-km in public transport	100	249
Tonne-km	100	422
Roads Passenger-km	100	961
Passenger-km by cars	100	1 207
Tonne-km	100	1 050
New registration of cars	100	2 085
Stock of cars	100	1 430
Railways Passenger-km	100	120
Tonne-km	100	92
Rail length	100	59
Economic indicators (at constant prices) GDP	100	349
C_p	100	270
C_{pt}	100	622
C_{ppt} (purchased transport)	100	195
Personal transport equipment	100	4 147
Operation of personal transport equipment	100	1 411

Table 1 *Norway*: Summary indicators of transport performance 1949-1989. 1949=100		
	1949	**1989**
Domestic transport Passenger-km	100	910
Passenger-km in public transport	100	234
Tonne-km	100	321
Roads Passenger-km	100	1 523
Passenger-km by cars	100	2 656
Tonne-km	100	1 367
New registration of cars	100	n a
Stock of cars	100	2 567
Railways Passenger-km	100	114
Tonne-km	100	150
Rail length	100	90
Economic indicators (at constant prices) GDP	100	459
C_p	100	330
C_{pt}	100	795
C_{ppt} (purchased transport)	100	240
Personal transport equipment	100	13 469
Operation of personal transport equipment	100	1 927

Table 1. Sweden: Summary indicators of transport performance 1949-1989. 1949=100		
	1949	**1989**
Domestic transport Passenger-km	100	688
Passenger-km in public transport	100	204
Tonne-km	100	374
Roads Passenger-km	100	1 145
Passenger-km by cars	100	1 829
Tonne-km	100	1 213
New registration of cars	100	2 218
Stock of cars	100	1 888
Railways Passenger-km	100	106
Tonne-km	100	236
Rail length	100	66
Economic indicators (at constant prices) GDP	100	341
C_p	100	271
C_{pt}	100	692
C_{ppt} (purchased transport)	100	165
Personal transport equipment	100	3 529
Operation of personal transport equipment	100	1 122